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Kawachi et al.

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(54) **ILLUMINATION DEVICE**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

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F21V 14/04	(2006.01)
F21W 131/405	(2006.01)
F21Y 101/00	(2016.01)

(52) **U.S. Cl.**

CPC ***F21V 21/34*** (2013.01); ***F21V 7/0033*** (2013.01); ***F21V 9/16*** (2013.01); ***F21V 13/14*** (2013.01); ***F21V 14/04*** (2013.01); *F21W 2131/405* (2013.01); *F21Y 2101/00* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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(57) **ABSTRACT**

An illumination device includes a light source configured to emit laser light, a transmission part configured to transmit the laser light emitted from the light source, and a lighting appliance configured to convert a wavelength of the laser light transmitted through the transmission part and to emit illumination light. The transmission part includes a rail-shaped guide part extending in a linear shape along a transmission direction of the laser light. The lighting appliance is configured to be mounted in an arbitrary position of the guide part.

7 Claims, 5 Drawing Sheets

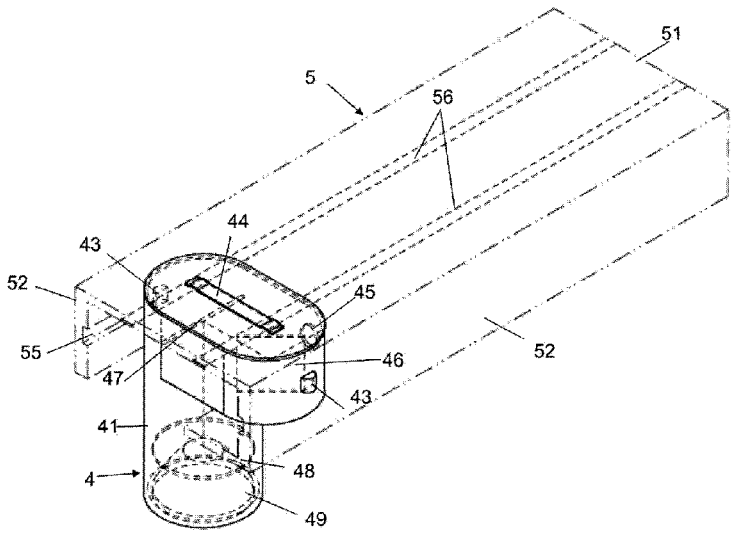


FIG. 1A

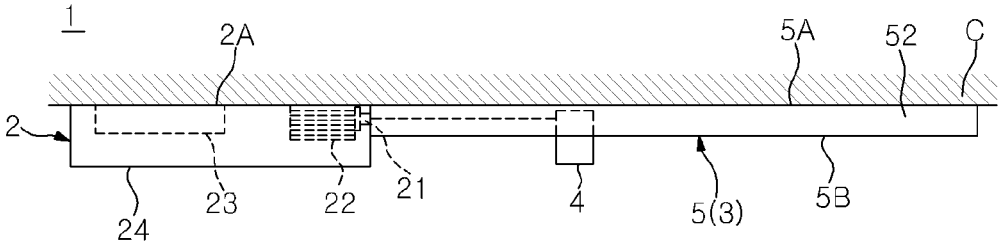


FIG. 1B

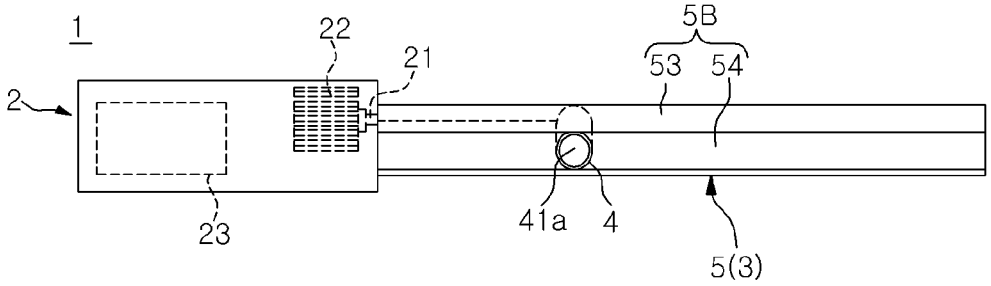


FIG. 2

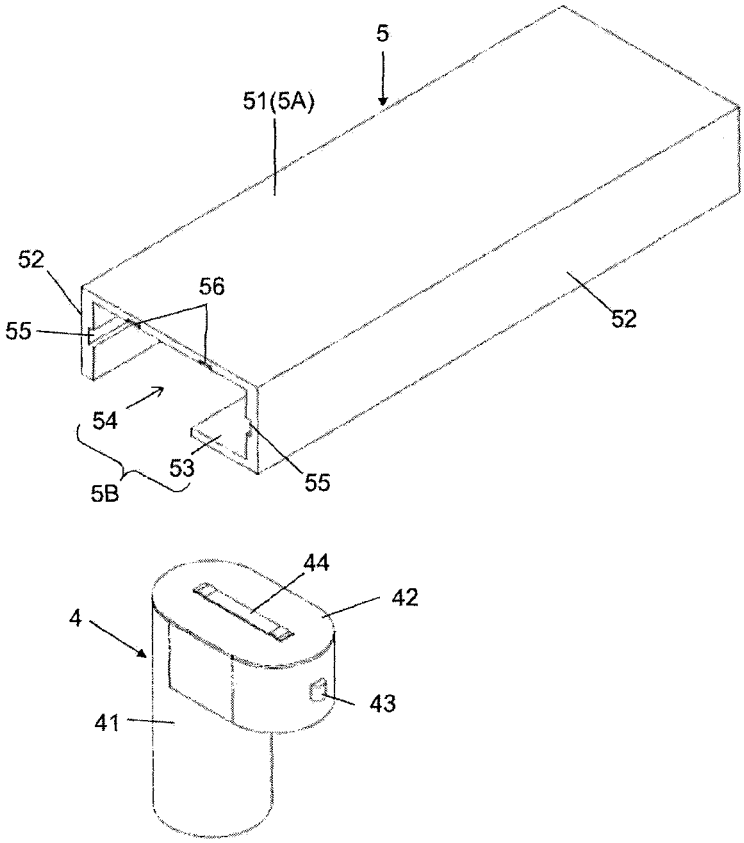


FIG. 3A

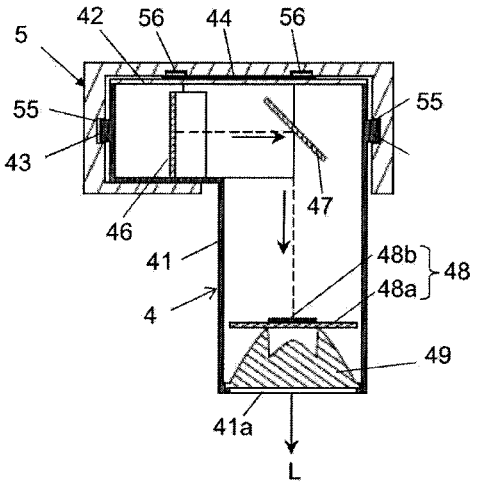

5
42
56
44
56
55
55
43
47
46
41
48b
48
48a
4
49
41a
L

FIG. 3B

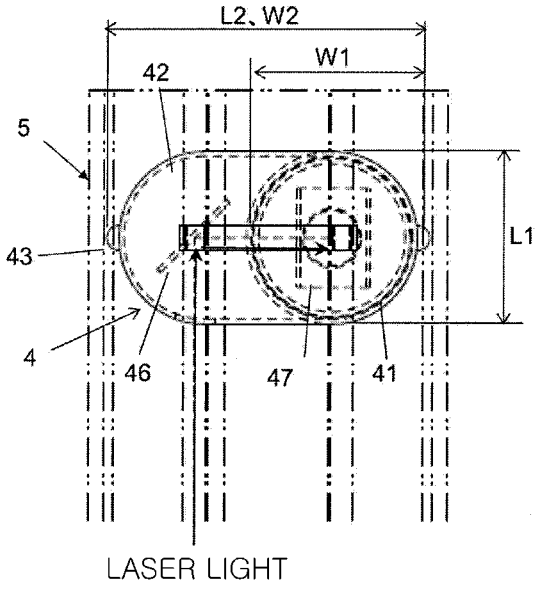
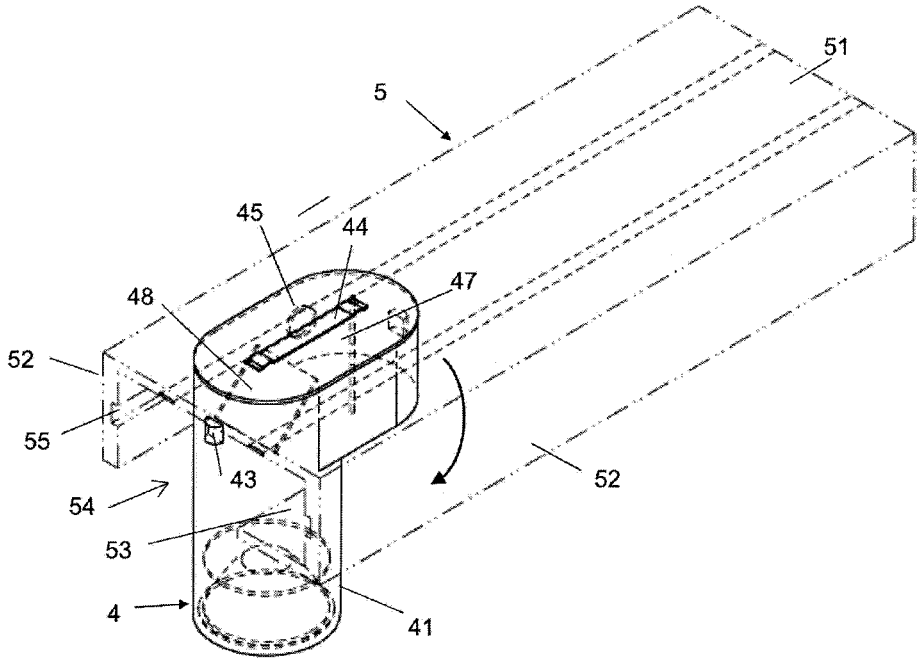

L2、W2
W1
42
5
L1
43
4
46
47
41
LASER LIGHT

FIG. 4A


51
5
45
44
47
48
52
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43
52
54
53
4
41

FIG. 4B

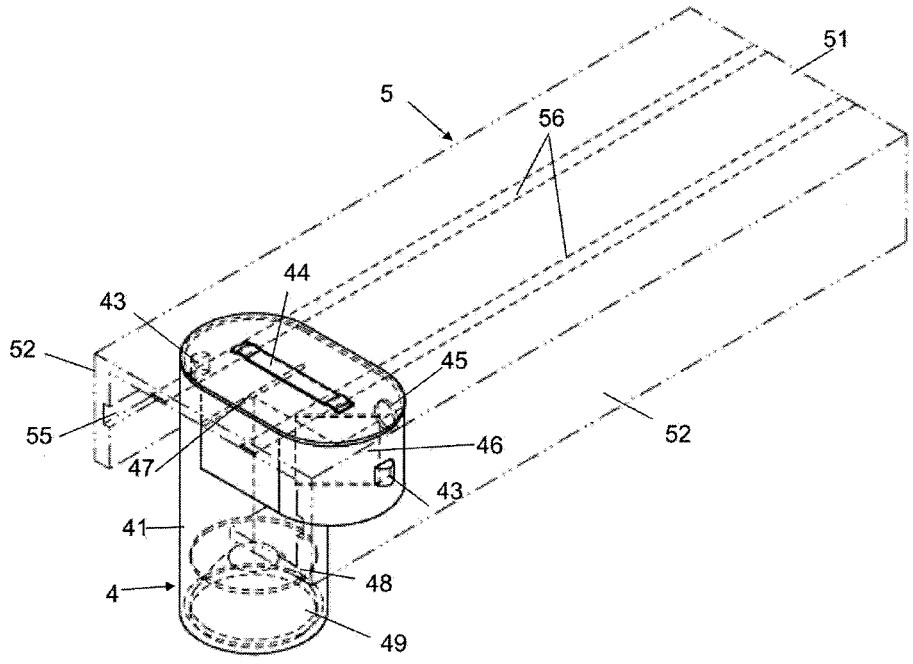
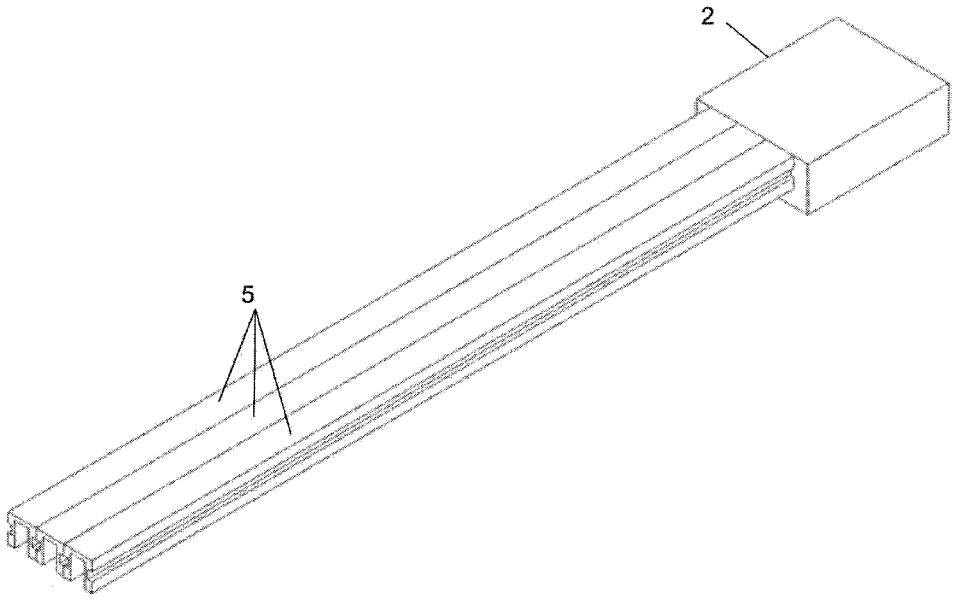

51
5
56
44
43
52
45
55
46
52
47
43
41
48
4
49

FIG. 5



ILLUMINATION DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to Japanese Patent Application No. 2015-128448, filed Jun. 26, 2015, the entire contents of which are hereby incorporated by reference.

TECHNICAL FIELD

The disclosure relates to an illumination device which uses a light source for emitting laser light.

BACKGROUND ART

Conventionally, a spotlight type illumination device is used in a show window or a museum to illuminate an object. In this illumination device, an LED or the like capable of emitting light at high efficiency has been extensively used. In recent years, there is known an illumination device which uses, as a light source, a semiconductor laser capable of emitting light at higher efficiency and higher output power than the LED (see, e.g., Japanese Unexamined Patent Application Publication No. 2014-175126 (JP2014-175126A)).

The illumination device disclosed in JP2014-175126A includes a light source configured to emit laser light and a plurality of light emitting units. Each of the light emitting units includes a linear light guide body having an incidence surface on which the laser light emitted from the light source is incident and an emission surface from which the incident laser light is emitted. The light source and each of the light emitting units are connected by an optical fiber. The laser light emitted from the light source is transmitted to each of the light emitting units through the optical fiber. Furthermore, the respective light emitting units are configured such that they can be disposed in a linear shape, a curve line shape or a bend line shape on a unit-by-unit basis.

Meanwhile, there is a spotlight type illumination device in which the installation position of a lighting appliance can be arbitrarily selected depending on the arrangement of an object to be irradiated with illumination light. However, in the illumination device disclosed in JP2014-175126A, the position of each of the light emitting units (lighting appliances) is fixed with respect to the light source for emitting laser light. It is therefore impossible to arbitrarily select the installation positions of the light emitting units depending on the use environment of the illumination device.

SUMMARY OF THE INVENTION

In view of the above, the present disclosure provides an illumination device capable of arbitrarily selecting the installation position of a lighting appliance which emits illumination light using a light source emitting laser light.

In accordance with an aspect, there is provided an illumination device, including: a light source configured to emit laser light; a transmission part configured to transmit the laser light emitted from the light source; and a lighting appliance configured to convert a wavelength of the laser light transmitted through the transmission part and to emit illumination light, wherein the transmission part includes a rail-shaped guide part extending in a linear shape along a transmission direction of the laser light, and the lighting appliance is configured to be mounted in an arbitrary position of the guide part.

According to the illumination device configured as above, the lighting appliance can be mounted in an arbitrary position of the rail-shaped guide part linearly extending along a transmission direction of laser light. This enables a user or other person to arbitrarily select the installation position of the lighting appliance which emits illumination light.

BRIEF DESCRIPTION OF THE DRAWINGS

The figures depict one or more implementations in accordance with the present teaching, by way of example only, not by way of limitations. In the figures, like reference numerals refer to the same or similar elements.

FIG. **1**A is a side view showing a configuration of an illumination device according to one embodiment, and FIG. **1**B is a front view thereof.

FIG. **2** is a perspective view of a guide part and a lighting appliance used in the illumination device.

FIG. **3**A is a sectional view orthogonal to the longitudinal direction of the guide part, showing side cross-sections of the lighting appliance and the guide part used in the illumination device, and FIG. **3**B is a partial perspective top view thereof.

FIGS. **4**A and **4**B are perspective views for explaining the procedure of mounting the lighting appliance used in the illumination device to the guide part.

FIG. **5** is a perspective view of an illumination device according to a modification of the aforementioned embodiment.

DETAILED DESCRIPTION

An illumination device according to one embodiment will be described with reference to FIGS. **1**A to **5**. As illustrated in FIGS. **1**A and **1**B, the illumination device **1** of the present embodiment is installed on an installation surface C of a ceiling or the like and is configured to irradiate illumination light primarily in a direction perpendicular to the installation surface C. The illumination device **1** includes a light source **2** configured to emit laser light, a transmission part **3** configured to transmit the laser light emitted from the light source **2**, and a lighting appliance **4** configured to convert a wavelength of the laser light transmitted through the transmission part **3** and to irradiate illumination light.

The transmission part **3** includes a rail-shaped guide part **5** which extends in an elongated shape along a transmission direction of the laser light. The light source **2** and the guide part **5** include installation surfaces **2**A and **5**A through which the light source **2** and the guide part **5** are fixed on the installation surface C, respectively. Furthermore, the guide part **5** includes a mounting surface **5**B at the opposite side of the installation surface **5**A and the lighting appliance **4** is mounted thereon.

The light source **2** includes a semiconductor laser element **21**, a heat dissipation part **22** for dissipating heat generated during the operation of the semiconductor laser element **21**, a lighting control circuit **23** for lighting the semiconductor laser element **21**, and a light source case **24** for accommodating the semiconductor laser element **21**, the heat dissipation part **22** and the lighting control circuit **23**. In the subject specification, the lighting control circuit **23** is described as one component of the light source **2**, which is accommodated within the light source case **24**. As an alternative example, the lighting control circuit **23** may be an independent component provided outside the light source case **24**.

A laser element configured to emit blue light having a wavelength of, for example, 440 nm to 455 nm, is used as the semiconductor laser element **21**. A lens (not shown) for converting the emitted laser light to substantially parallel light is provided in an emission portion of the semiconductor laser element **21**. The heat dissipation part **22** is made of a metal having high heat dissipation, such as an aluminum alloy or the like. A general-purpose die-cast member provided with fins for improving heat dissipation is used as the heat dissipation part **22**. The lighting control circuit **23** includes a rectifier transformer circuit (not shown) which converts an electric current received from a commercial power source (not shown) to a predetermined direct current and controls a voltage applied to control the output of the semiconductor laser element **21** so as to correspond to a predetermined output control signal. The light source case **24** is a box-shaped structure made of, for example, stainless steel or the like. A guide part **5** is connected to one surface of the light source case **24**.

As illustrated in FIG. **2**, the rail-shaped guide part **5** includes a flat bottom wall **51** extending in the longitudinal direction of the guide part **5** to define the installation surface **5**A and opposite side walls **52** formed at the opposite edges of the bottom wall **51**. Furthermore, the guide part **5** includes a mounting surface **5**B extending substantially parallel to the installation surface **5**A. The mounting surface **5**B includes a cover portion **53** configured to surround a space through which the laser light emitted from the light source **2** is transmitted in the air and an opening portion **54** formed at a predetermined width along the cover portion **53**. The lighting appliance **4** is fitted to the opening portion **54** and is mounted to the guide part **5** in the below-described order.

Engagement grooves **55**, in which the below-described projection portions **43** of the lighting appliance **4** are engaged, are formed on the inner surfaces of the side walls **52** of the guide part **5** over the total length of the guide part **5**. Furthermore, a pair of electrodes **56** is formed on the surface of the bottom wall **51** facing toward the mounting surface **5**B over the total length of the guide part **5** (see FIGS. **4**A and **4**B). The electrodes **56** are connected to the lighting control circuit **23** of the light source **2**, which is not illustrated.

The lighting appliance **4** includes a cylindrical lighting appliance case **41**, a mounting portion **42** for mounting the lighting appliance **4** to the guide part **5**, and projection portions **43** provided in the mounting portion **42** and engaged in the engagement grooves **55** of the guide part **5**. The lighting appliance case **41** has an internal space for accommodating the below-described wavelength conversion part **48** and the like. Furthermore, the lighting appliance case **41** is provided on its bottom surface with an opening **41***a* from which illumination light is emitted (see FIG. **1**B).

The mounting portion **42** is a cylindrical structural member having two mutually-orthogonal sides differing in length from each other when viewed in the direction perpendicular to the mounting surface **5**B and having a cross section of a transversely-elongated elliptical shape. The mounting portion **42** is provided so as to transversely protrude from the top end of the lighting appliance case **41**. The interior of the mounting portion **42** communicates with the internal space of the lighting appliance case **41**. Furthermore, the shorter side length L**1** of the mounting portion **42** corresponds to the width W**1** of the opening portion **54**, and the longer side length L**2** of the mounting portion **42** corresponds to the internal width W**2** of the guide part **5** (see FIG. **3**B which will be described later). Moreover, the lighting appliance **4** includes a leaf spring **44** provided on the top surface of the lighting appliance case **41** and configured to short-circuit the electrodes of the guide part **5** when the lighting appliance **4** is mounted to the guide part **5**. The leaf spring **44** is formed of an electrically conductive member.

The mounting portion **42** has a hole portion **45** formed on a longer side surface and configured to introduce the transmitted laser light into the lighting appliance **4** via the space surrounded by the cover portion **53** (see FIGS. **4**A and **4**B). As illustrated in FIGS. **3**A and **3**B, the lighting appliance **4** further includes a first reflection portion **46** configured to reflect the laser light introduced through the hole portion **45** in the width direction of the guide part **5** and a second reflection portion **47** configured to reflect the laser light reflected by the first reflection portion **46** in the direction perpendicular to the mounting surface **5**B. The first reflection portion **46** and the second reflection portion **47** are respectively fixed to the mounting portion **42** and the interior of the lighting appliance case **41** at an angle inclined with respect to the transmission direction of the laser light so as to reflect the laser light at an angle of 90 degrees.

The lighting appliance **4** further includes a wavelength conversion part **48** configured to convert a wavelength of the laser light reflected by the second reflection portion **47** and to emit the wavelength-converted laser light as illumination light, and an optical member **49** configured to control distribution of the light emitted from the wavelength conversion part **48** and to generate substantially parallel light.

The wavelength conversion part **48** is formed of a phosphor plate which includes a phosphor configured to convert the wavelength of the laser light emitted from the light source **2** and to emit the wavelength-converted laser light. The wavelength conversion part **48** includes a substrate **48***a* and a phosphor **48***b* formed on the substrate **48***a* in a film shape. For example, a crystalline substrate made of glass, quartz, sapphire or the like or a sintered substrate made of spinel or the like may be used as the substrate **48***a*. Since the material such as quartz, sapphire or the like is high in heat conductivity and superior in heat dissipation, it is particularly preferable to use the material such as quartz, sapphire or the like. For example, a yellow phosphor excited by blue laser light to emit yellow light may be used as the phosphor **48***b*. The wavelength conversion part **48** is configured to emit white illumination light obtained by mixing the blue laser light transmitted from the light source **2** and the yellow light generated by the light emission of the phosphor.

As illustrated in FIG. **4**A, the guide part **5** of the illumination device **1** is fixed to the installation surface C (see FIG. **1**) in advance. The lighting appliance **4** is inserted into the opening portion **54** of the guide part **5** in a state that the long side of the mounting portion **42** extends in the longitudinal direction of the guide part **5**. A user or other person rotates the lighting appliance **4** by 90 degrees in a state in which the upper surface of the lighting appliance **4** reaches the bottom wall **51** of the guide part **5**. Then, as illustrated in FIG. **4**B, the mounting portion **42** laterally protruding from the lighting appliance case **41** comes into a region surrounded by the cover portion **53**. The projection portions **43** provided at the opposite ends of the mounting portion **42** are respectively fitted in the engagement grooves **55** of the guide part **5**. Furthermore, the leaf spring **44** on the top surface of the lighting appliance **4** makes contact with the electrodes **56** provided in the guide part **5**, thereby short-circuiting the electrodes **56**.

The lighting control circuit **23** of the light source **2** drives the semiconductor laser element **21** using the short-circuiting of the electrodes **56** as a trigger signal. The blue laser light emitted from the semiconductor laser element **21** is

transmitted to the lighting appliance **4** through the space surrounded by the cover portion **53** of the guide part **5**. The blue laser light is reflected by the first reflection portion **46** and the second reflection portion **47** and is incident on the wavelength conversion part **48**. Then, the wavelength conversion part **48** converts the blue laser light to white illumination light L. The illumination light L (indicated by a lower arrow in FIG. **3**A) is distribution-controlled by the optical member **49** and is emitted to the outside of the lighting appliance **4**.

According to the illumination device **1** configured as above, the lighting appliance **4** can be mounted in an arbitrary position of the rail-shaped guide part **5** extending in the transmission direction of the laser light. This enables a user or other person to arbitrarily select the installation position of the lighting appliance **4** which emits illumination light.

Since the laser light emitted from the light source **2** is transmitted to the lighting appliance **4** through the space surrounded by the cover portion **53** of the guide part **5**, the lighting appliance **4** can be slidingly moved while transmitting the laser light emitted from the light source **2** to the lighting appliance **4**. Thus, the lighting appliance **4** is slidingly movable even under a state in which the lighting appliance **4** is mounted to the guide part **5** and is allowed to emit illumination light. Accordingly, a user or other person can arbitrarily select the installation position of the lighting appliance **4** which emits illumination light, while turning on the lighting appliance **4** in conformity with an object to be illuminated in the installation place of the illumination device **1**. Furthermore, the light path of the laser light is surrounded by the cover portion **53**. The laser light is reflected by the first reflection portion **46** in the mounting portion **42** and the second reflection portion **47** in the lighting appliance case **41** toward the opening portion **54**. Thus, the laser light is invisible in the position just below the guide part **5** and is not leaked to the outside of the guide part **5**. This makes it possible to improve the appearance of the illumination device **1**.

Furthermore, the shorter side length L**1** of the mounting portion **42** corresponds to the width W**1** of the opening portion **54**, and the longer side length L**2** of the mounting portion **42** corresponds to the internal width W**2** of the guide part **5**. Thus, by inserting the lighting appliance **4** into the opening portion **54** and rotating the lighting appliance **4** by 90 degrees, a user or other person can easily install the lighting appliance **4** in the guide part **5** without having to use an additional tool or the like.

In the lighting appliance **4**, the laser light transmitted through the space surrounded by the cover portion **53** can be reflected by the first reflection portion **46** and the second reflection portion **47** in the direction perpendicular to the mounting surface **5**B of the guide part **5**, whereby the illumination light can be irradiated in the direction perpendicular to the mounting surface **5**B through the wavelength conversion part **48**. Thus, the illumination device **1** can be suitably used as a spotlight. Moreover, the light source **2** emits laser light when the electrodes **56** of the guide part **5** are short-circuited, namely when the lighting appliance **4** is mounted to the guide part **5**. It is therefore possible to prevent laser light from being unnecessarily emitted.

Next, an illumination device **1** according to a modification of the aforementioned embodiment will be described with reference to FIG. **5**. The illumination device **1** according to this modification includes a plurality of guide parts **5** and a plurality of lighting appliances **4**. The guide parts **5** are disposed in parallel and the lighting appliances **4** are mounted to the respective guide parts **5**. A plurality of semiconductor laser elements **21** (not shown) is provided in the light source **2**. Laser light is transmitted from each of the semiconductor laser elements **21** to each of the lighting appliances **4**.

According to the illumination device **1** of the aforementioned embodiment, it is possible to arbitrarily select the fixing relationship of the lighting appliance **4** with respect to the light source **2**. If the length of the guide parts **5** is sufficient, it is possible to increase the distance between the light source **2** and the lighting appliance **4**. Thus, the light source **2** including the heat dissipation part **22** having a specified size can be installed in an inconspicuous position under the installation environment of the illumination device **1**. The guide part **5** extends from the light source **2**. The lighting appliance **4**, which is small and inconspicuous, can be installed near (for example, just above) an object to be illuminated. In the illumination device **1** of the aforementioned embodiment, the light source **2** and the lighting appliance **4** are in a one-to-one correspondence relationship. Therefore, for example, if the installation environment of the illumination device **1** is wide, it may be impossible to illuminate a plurality of objects or a wide range in case where only one lighting appliance **4** is available. In contrast, according to this modification, the use of a plurality of lighting appliances **4** makes it possible to illuminate a plurality of objects or a wide range. By mounting the plurality of lighting appliances **4** to the respective guide parts **5**, it is possible to arbitrarily select the installation positions of the respective lighting appliances **4**.

The present invention is not limited to the aforementioned embodiment but may be modified in many different forms. For example, the guide part **5** is a rail-shaped member extending in a linear shape. As an alternative example, a plurality of guide parts **5** cut into a predetermined length may be connected at an arbitrary angle. A reflection plate (not shown) which reflects laser light at the arbitrary angle may be provided in the region of the connection portion surrounded by the cover portion **53**. By doing so, the laser light is transmitted through the respective guide parts **5** in a parallel relationship with the longitudinal direction of the guide parts **5**. Therefore, similar to the aforementioned embodiment, the laser light can be picked up by the first reflection portion **46** and the second reflection portion **47** of the lighting appliance **4**. Then, the laser light can be wavelength-converted so as to emit illumination light from the lighting appliance **4**.

While the foregoing has described what are considered to be the best mode and/or other examples, it is understood that various modifications may be made therein and that the subject matter disclosed herein may be implemented in various forms and examples, and that they may be applied in numerous applications, only some of which have been described herein. It is intended by the following claims to claim any and all modifications and variations that fall within the true scope of the present teachings.

What is claimed is:

1. An illumination device, comprising:

a light source configured to emit laser light;

a transmission part configured to transmit the laser light emitted from the light source; and

a lighting appliance configured to convert a wavelength of the laser light transmitted through the transmission part and to emit illumination light,

wherein the transmission part includes a rail-shaped guide part extending in a linear shape along a transmission direction of the laser light,

the lighting appliance is configured to be mounted in an arbitrary position of the guide part,

the guide part includes a mounting surface on which the lighting appliance is mounted, the mounting surface extending a longitudinal direction of the guide part,

the mounting surface includes a cover portion configured to surround a space through which the laser light is transmitted in air and an opening portion opened at a predetermined width along the cover portion, and

the lighting appliance is fitted to the opening portion.

2. The device of claim **1**,

wherein the lighting appliance includes a mounting portion for mounting the lighting appliance to the guide part, the mounting portion having two mutually-orthogonal sides differing in length from each other when viewed in a direction perpendicular to the mounting surface,

a shorter side length of the mounting portion corresponding to a width of the opening portion, and

a longer side length of the mounting portion corresponding to an internal width of the guide part.

3. The device of claim **2**,

wherein the lighting appliance includes a first reflection portion configured to reflect the laser light transmitted through a space surrounded by the cover portion in a width direction of the guide part and a second reflection portion configured to reflect the laser light reflected by the first reflection portion in the direction perpendicular to the mounting surface.

4. The device of claim **2**,

wherein the guide part includes a plurality of guide parts,

the lighting appliance includes a plurality of lighting appliances, and

each of the lighting appliances is mounted to each of the guide parts through the mounting portion.

5. The device of claim **1**,

wherein the guide part includes a pair of electrodes extending in a longitudinal direction of the guide part,

the lighting appliance includes an electrically conductive member configured to short-circuit the electrodes when the lighting appliance is mounted to the guide part, and

the light source is configured to emit the laser light when the electrodes are short-circuited.

6. The device of claim **5**,

wherein the pair of electrodes extend over the total length of the guide part.

7. The device of claim **1**,

wherein the lighting appliance further includes a leaf spring provided on a top surface thereof,

the guide part further includes a pair of electrodes, and

the leaf spring is configured to make contact with the pair of electrodes and short-circuit the electrodes when the lighting appliance is mounted to the guide part.

* * * * *